Dynamic Sensor Networks

DARPA SensIT PI Meeting

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Dynamic Sensor Networks

SensIT

- **The DSN team has focused on research issues related to the topographical nature of unattended ground sensors**

- **Topographical map interface for real and simulated sensor fields.**
  - Live situation awareness visualization using a low-power hand-held device.
  - Tools for sensor network deployment planning and scenario construction.
  - Sensor network control and maintenance.
- **Tools for sensor network simulation.**
  - Hybrid simulation of real/virtual nodes.
  - Energy consumption modeling.
- **Network protocols for spatially distributed systems.**
  - Low-power link protocols.
  - Spatial addressing and routing protocols.
  - Protocols for GPS-less localization.
- **Platform concept prototypes.**
  - GPS sync radio board.
  - Experimental iPAQ video node.

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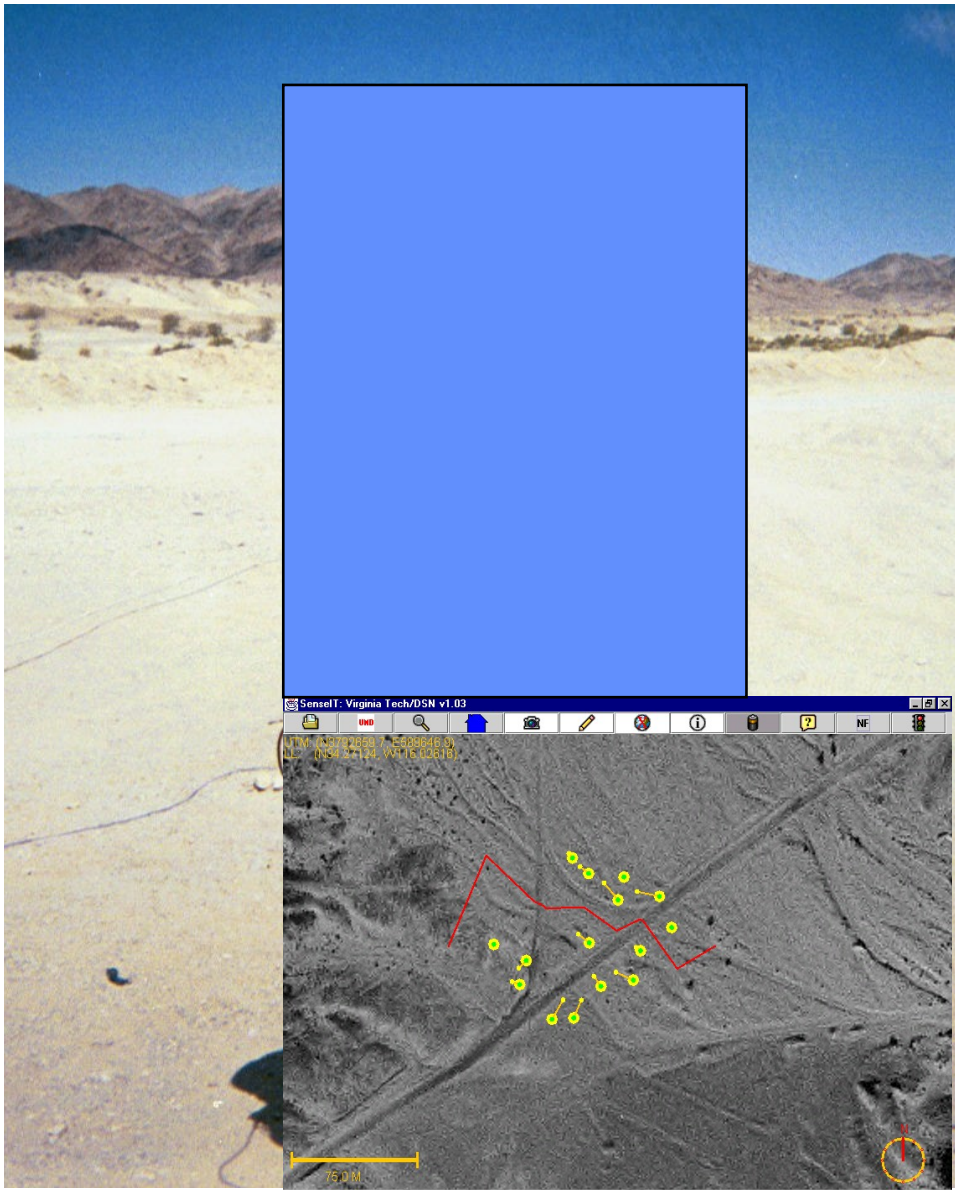
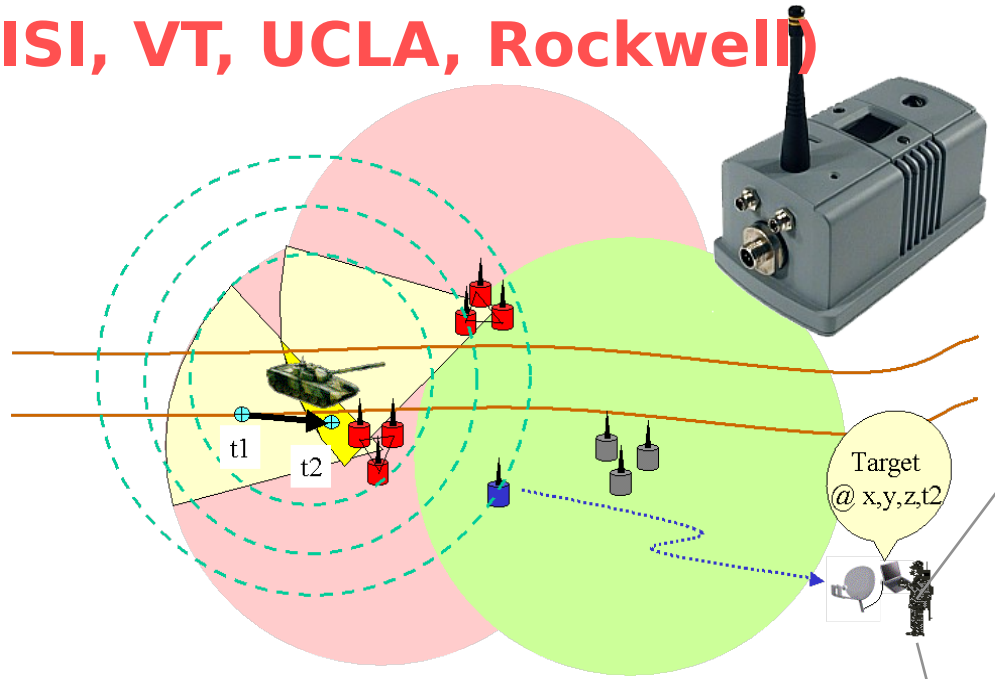
SITEX00, 29 Palms, August 2000

- **Prototype user platform was laptop, HUD, GPS, compass.**
  - Own location/bearing in sensor network on topographical display.
  - Eventual target is PDA.
- **GUI communicated with Sensoria 1.0 nodes in field using instrumentation Ethernet backbone (wired).**
  - Tracked GPS location variation from surveyed positions.
  - Exercised UCLA (Sensorware) maximal breach path algorithm as sensor nodes were physically moved.

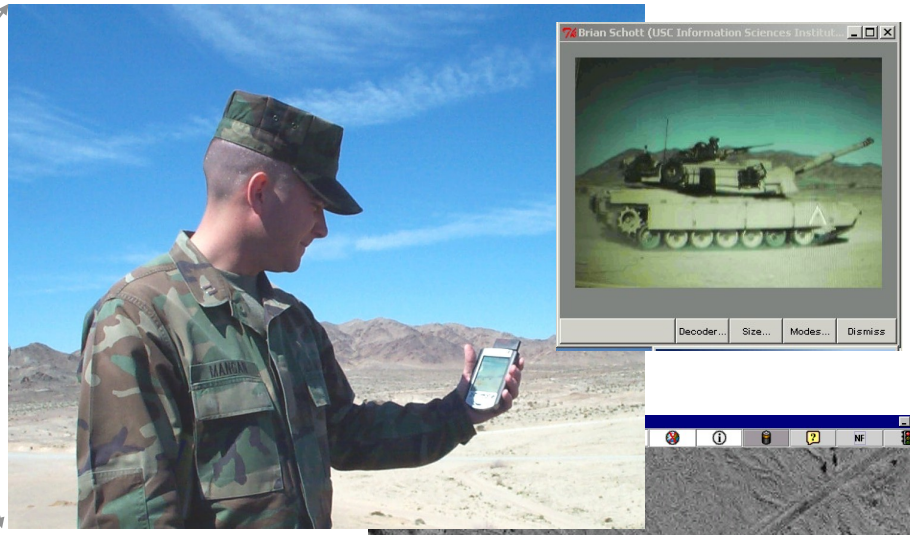


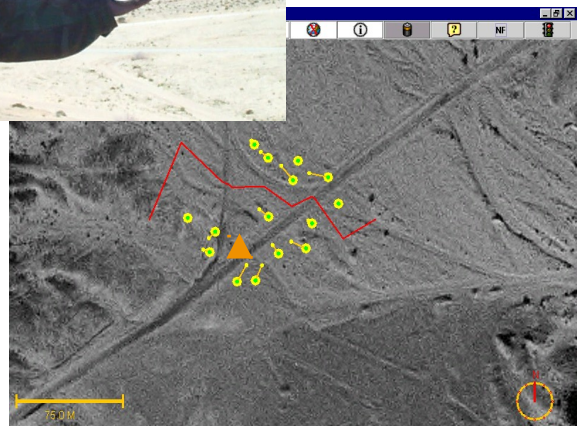
SITEX01, 29 Palms, March 2001

(ISI, VT, UCLA, Rockwell)



- **At Base Camp:**
  - VT GUI display on laptop of node locations, tracks, and live GPS ground truth (over 802.11 LAN).
  - Live video feed on wireless IPAQ PDA (from sender laptop in field).





- **In Sensor Field:**
  - Tested Wave Intensity Comparison - a RSC 2D tracker based on seismic signal energy level comparison.
  - Nine Rockwell HYDRA nodes.
  - COTS 802.11 wireless Ethernet bridge to base camp (~1km).
  - Laptop with USB web cam.

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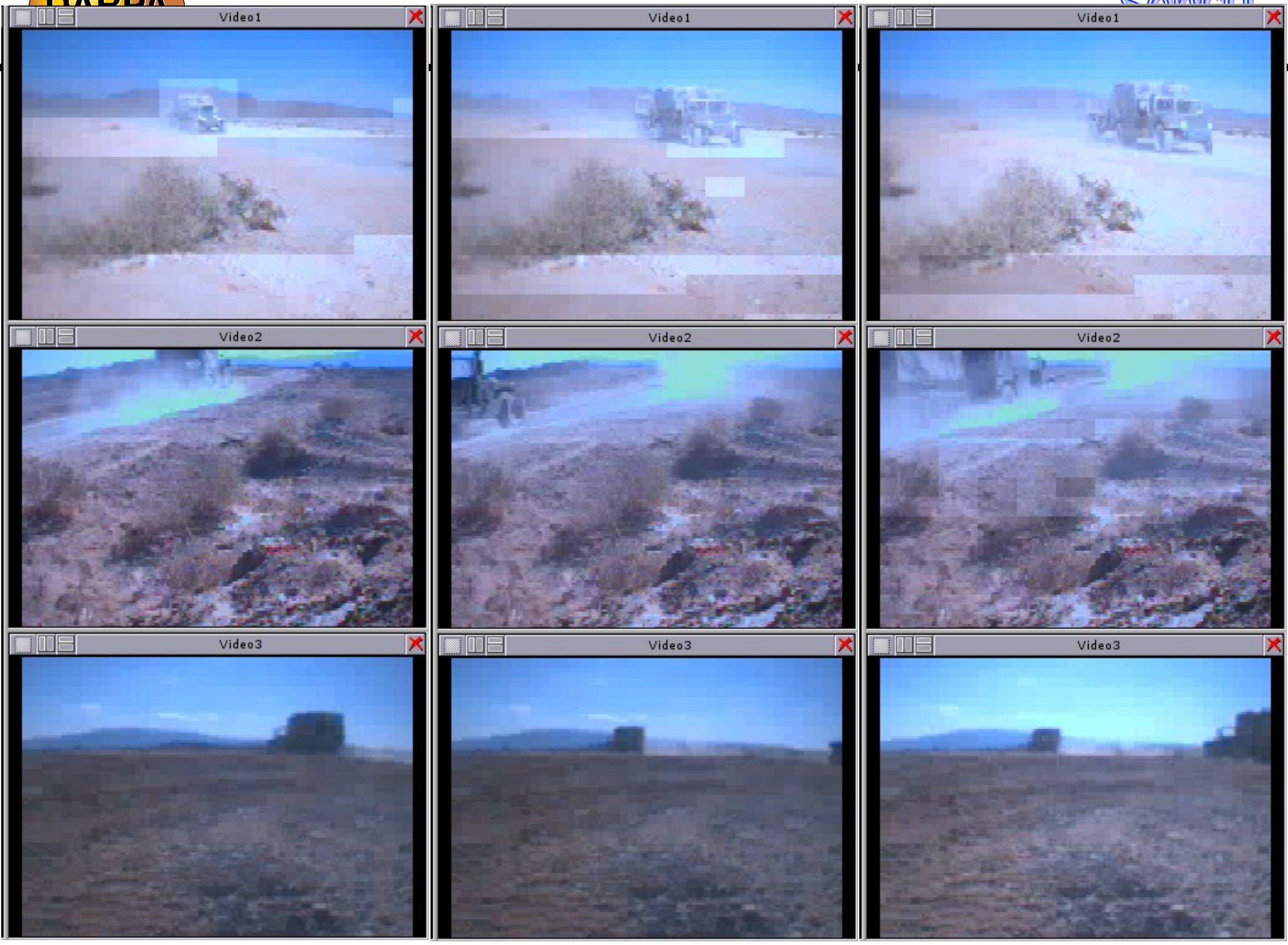
SITEX02, 29 Palms, Nov. 2001

- **ISI team experimented with three iPAQ-based video sender nodes and collected video baseline of several vehicles.**
  - RTP packet dumps and VHS video tape.
- **VT team supported BBN integrated experiment with Sensoria 2.0 nodes.**
- **UCLA ran developmental experiments on sensor field coverage algorithms (under Sensorware project).**

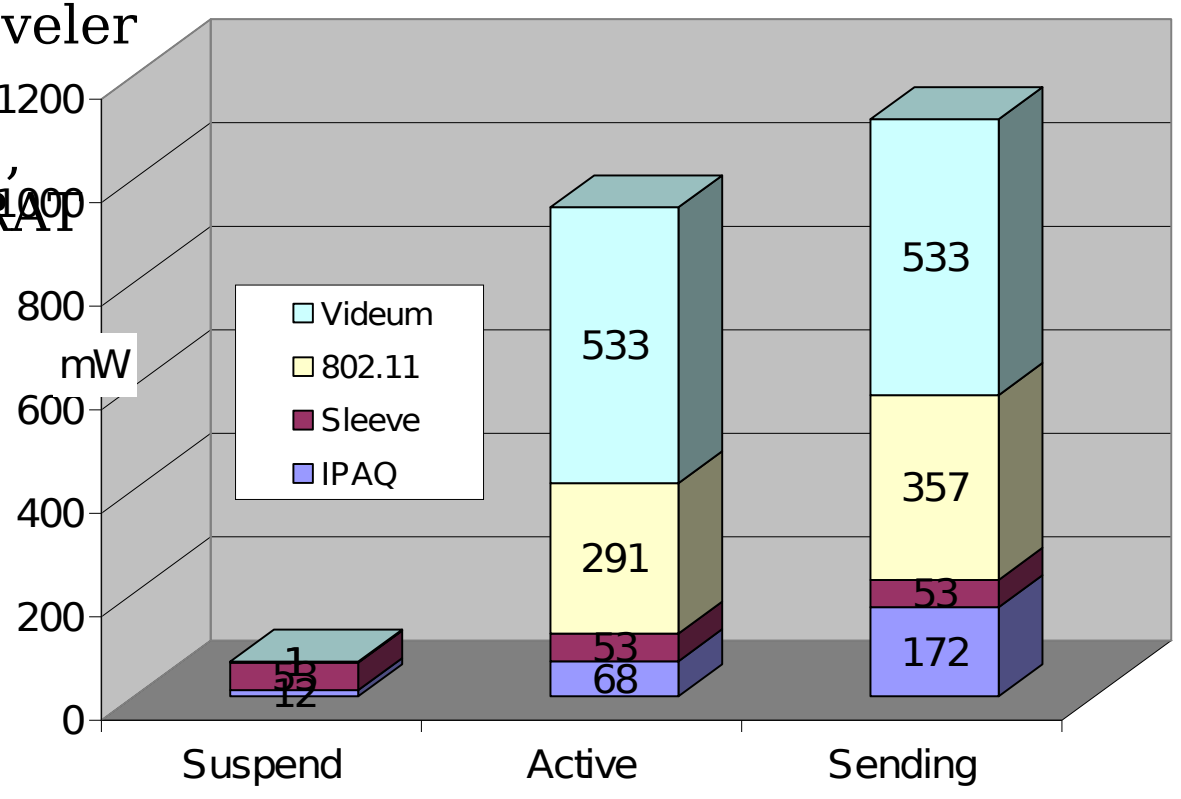

Video1
Video1
Video1
Video2
Video2
Video2
Video3
Video3
Video3

AAV Coming

AAV Going

IPAQ Video Sender

- **Video Sender Baseline Node**
  - Compaq IPAQ (206MHz SA1110).
  - Compaq dual PCMCIA sleeve.
  - Cabletron RoamAbout 802.11b Ethernet PCMCIA.
  - Winnov Videum Traveler
- **Overall power consumption about 1.1W (4.1V) at ~18fps.**
- **More efficient CF cameras coming on the market.**

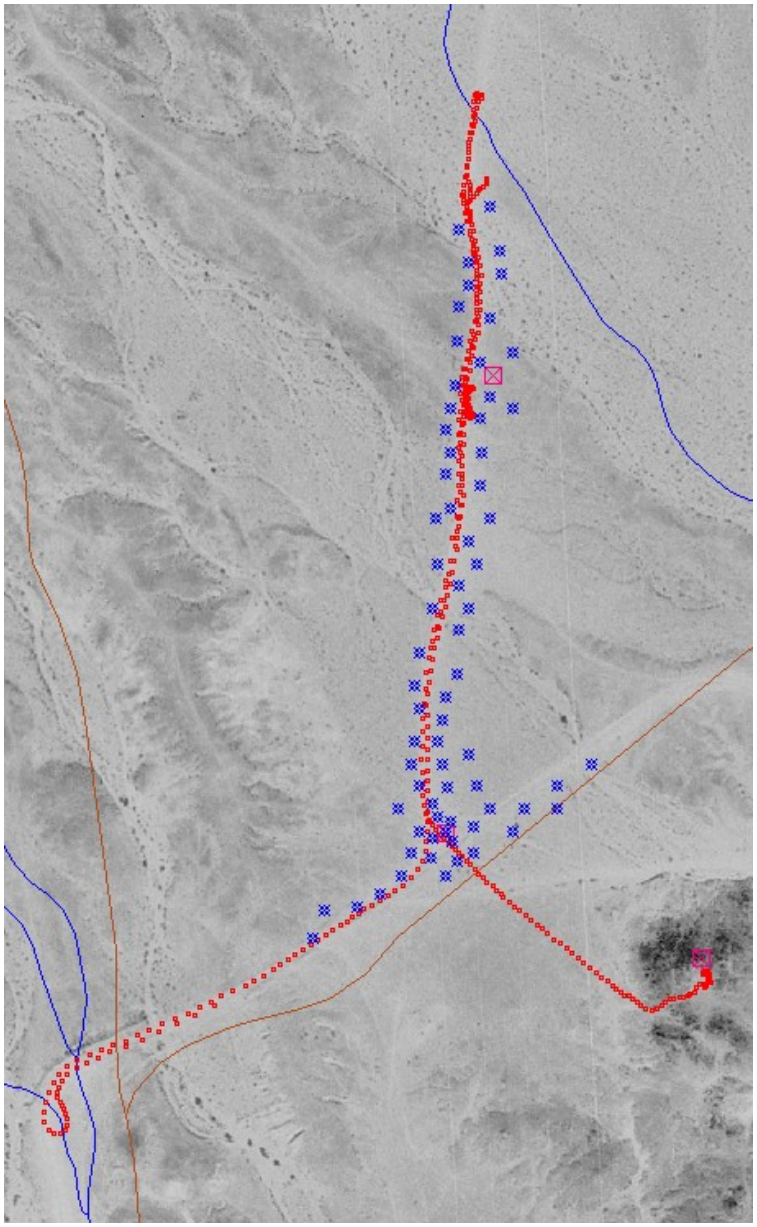


VIC Video Rates on iPAQ

Codec	Lens covered		Still scene		Moving camera		Image Quality (subjective)
	Frame rate	Network traffic	Frame rate	Network traffic	Frame rate	Network traffic	
nv	18 fps	90 kb/s	18 fps	100 kb/s	18 fps	1200 kb/s	Good
nvdct	18 fps	91 kb/s	18 fps	67 kb/s	18 fps	680 kb/s	Good
cellb	18 fps	28 kb/s	18 fps	30 kb/s	18 fps	800 kb/s	Poor
jpeg	0.5 fps	5 kb/s	0.5 fps	8 kb/s	0.5 fps	8 kb/s	Fair
h261	17 fps	46 kb/s	17 fps	30 kb/s	0.7 fps	9 kb/s	Good
bvc	18 fps	19 kb/s	18 fps	18 kb/s	18 fps	500 kb/s	Good
h263+	0.1 fps	1 kb/s	0.1 fps	1 kb/s	0.1 fps	1 kb/s	Fair
h263	15 fps	18 kb/s	15 fps	14 kb/s	1.3 fps	25 kb/s	Fair

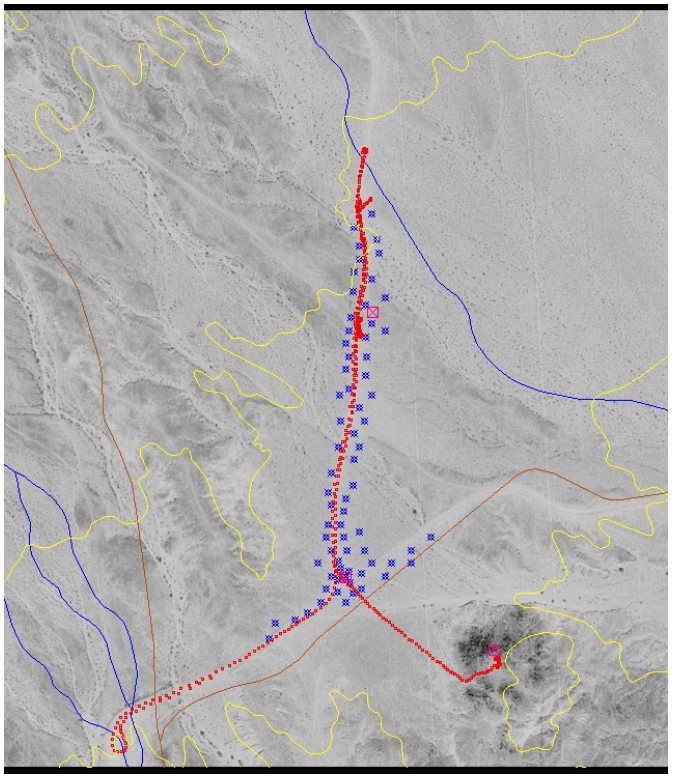
GRASS on IPAQ

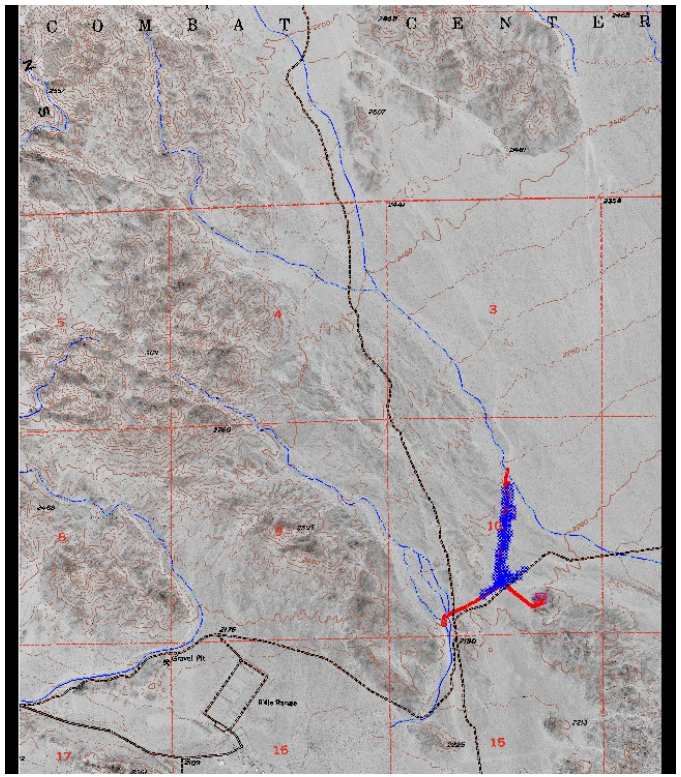
- GRASS (Geographic Resources Analysis Support System) is a GPL open source Geographical Information System (GIS).
- GRASS provides raster, topological vector, image processing, and graphics production functionality using an X-windows GUI and shell commands.
- There is active research in this field on temporal GIS display systems.
- ISI ported GRASS to IPAQ for our own handheld displays and are feeding results back into the research community.
- Very little code is required to overlay GIS datasets on a sensor field display.

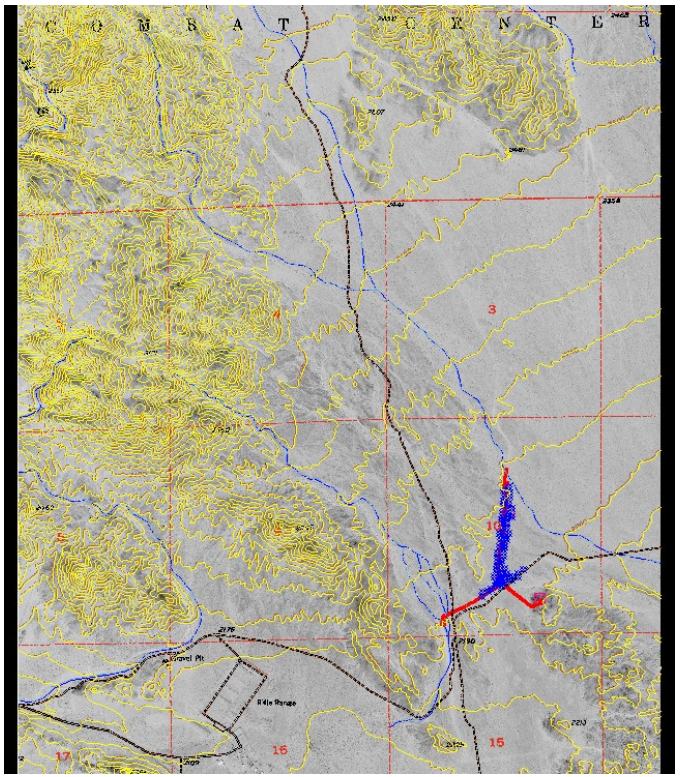


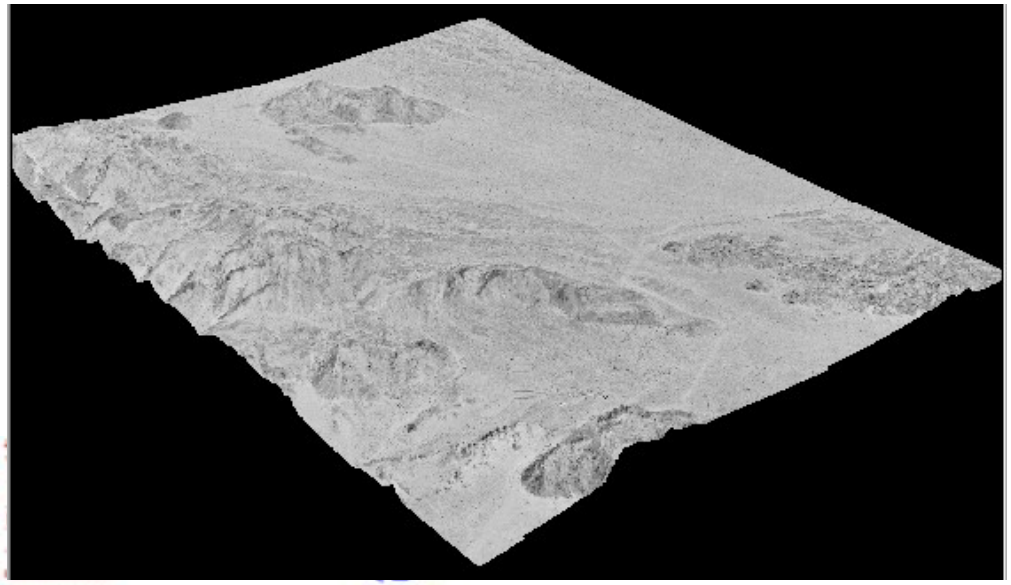
http://www.baylor.edu/grass/

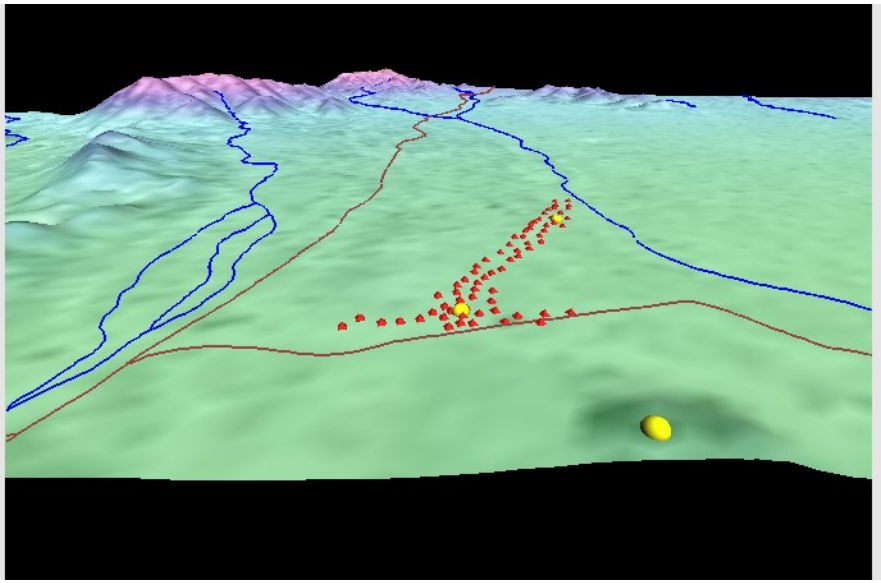
Visualization of SITEX02





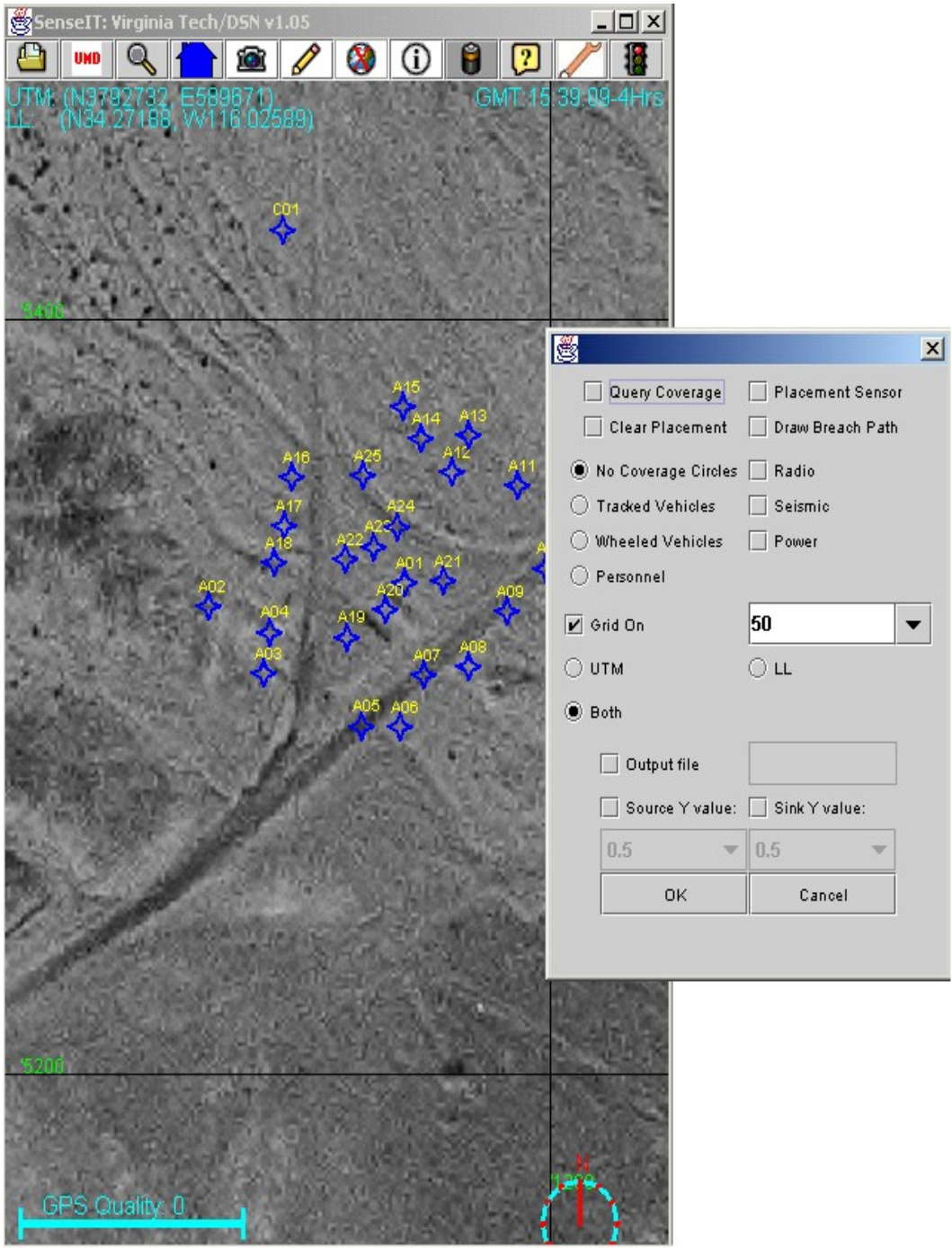






SensIT Integration GUI

- **SensIT Integration GUI developed by VT under DSN.**
  - Main components include query request input, sensor network response display, and node status.
  - Query parameters include area, target class, and event type.
  - Responses include CPA detection events, tracks, and images.
- **GUI has been used in every exercise in SensIT.**
  - SITEX00 with Sensoria 1.0 for node coverage experiment.
  - SITEX01 with HYDRA for RSC tracker and live GPS ground truth.
  - SITEX02 with Sensoria 2.0 for integrated node and track display.



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Lessons Learned from SITEX02

- **"Day in Life of Query" thought exercise was very valuable.**
  - It worked out high-level module interactions, but did not extend down to enough API detail.
- **A schema is not a specification.**
  - It defines syntax, not semantics.
  - Misunderstandings of units, meaning, and timing all lead to integration delays.
- **Simulation is a valuable tool for distributed code development.**
  - VT and UMD were able to eliminate misunderstandings between GUI and gateway well before SITEX02.
- **Regression testing is key.**
  - Not as glamorous as holistic approach, but certainly more efficient with a distributed development team.